

CALIBRATION DATA MEASUREMENTS

Parameter	Symbol	Units	Tolerances
Barometric Pressure (corrected)	P_B	kPa	±.34 kPa
Air temperature, into flowmeter	ETI	° C	±.28° C
Pressure drop between the inlet and throat of metering venturi.	EDP	in. H ₂ O	±.05 in H ₂ O
Air flow	Q_s	m ³ /min	±.5 percent of NIST value
CFV inlet depression	PPI	(kPa)	±.055 kPa
Temperature at venturi inlet	T_v	° C	±2.22° C

(4) Set up equipment as shown in Figure 6 in Appendix B of this subpart and eliminate leaks. (Leaks between the flow measuring devices and the critical flow venturi will seriously affect the accuracy of the calibration.)

(5) Set the variable flow restrictor to the open position, start the blower, and allow the system to stabilize. Record data from all instruments.

(6) Vary the flow restrictor and make at least eight readings across the critical flow range of the venturi.

(7) *Data analysis.* The data recorded during the calibration are to be used in the following calculations:

(i) Calculate the air flow rate (designated as Q_s) at each test point in standard cubic feet per minute from the flow meter data using the manufacturer's prescribed method.

(ii) Calculate values of the calibration coefficient for each test point:

Where:

Q_s =Flow rate in standard cubic meters per minute, at

$$K_v = \frac{Q_s \sqrt{T_v}}{P_v}$$

the standard conditions of 20° C, 101.3 kPa.

T_v =Temperature at venturi inlet, °K.

P_v =Pressure at venturi inlet, kPa= $P_B - P_{PI}$

Where:

P_{PI} =Venturi inlet pressure depression, kPa.

(iii) Plot K_v as a function of venturi inlet pressure. For choked flow, K_v will have a relatively constant value. As pressure decreases (vacuum increases), the venturi becomes unchoked and K_v decreases. (See Figure 7 in Appendix B to Subpart D.)

(iv) For a minimum of eight points in the critical region, calculate an average K_v and the standard deviation.

(v) If the standard deviation exceeds 0.3 percent of the average K_v , take corrective action.

(e) *CVS system verification.* The following "gravimetric" technique may be used to verify that the CVS and analytical instruments can accurately measure a mass of gas that has been injected into the system. (Verification can also be accomplished by constant flow metering using critical flow orifice devices.)

(1) Obtain a small cylinder that has been charged with 99.5 percent or greater propane or carbon monoxide gas (CAUTION—carbon monoxide is poisonous).

(2) Determine a reference cylinder weight to the nearest 0.01 grams.

(3) Operate the CVS in the normal manner and release a quantity of pure propane into the system during the sampling period (approximately five minutes).

(4) The calculations are performed in the normal way except in the case of propane. The density of propane (0.6109 kg/m³/carbon atom) is used in place of the density of exhaust hydrocarbons.

(5) The gravimetric mass is subtracted from the CVS measured mass and then divided by the gravimetric mass to determine the percent accuracy of the system.

(6) Good engineering practice requires that the cause for any discrepancy greater than ± two percent must be found and corrected.

§ 90.425 CVS calibration frequency.

Calibrate the CVS positive displacement pump or critical flow venturi following initial installation, major

maintenance, or as necessary when indicated by the CVS system verification (described in § 90.424(e)).

§ 90.426 Dilute emission sampling calculations—gasoline fueled engines.

(a) The final reported emission test results must be computed by use of the following formula:

$$A_{WM} = \frac{\sum_i^n (W_i \cdot WF_i)}{\sum_i^n (P_i \cdot WF_i)} \cdot K_{Hi}$$

Where:

A_{WM} =Final weighted brake-specific mass emission rate for an emission (HC, CO, CO₂, or NO_x) [g/kW-hr]

W_i =Average mass flow rate of an emission (HC, CO, CO₂, NO_x) from a test engine during mode i [g/hr]

WF_i =Weighting factor for each mode i as defined in § 90.410(a).

P_i =Gross average power generated during mode i [kW], calculated from the following equation,

$$P_i = \frac{2\pi}{60,000} \times \text{speed} \times \text{torque}$$

Where:

speed=average engine speed measured during mode i [rev./minute]

torque=average engine torque measured during mode i [N-m]

K_{Hi} =NO_x humidity correction factor for mode i. This correction factor only affects calculations for NO_x and is equal to one for all other emissions. K_{Hi} is also equal to 1 for all two-stroke engines.

(b) The mass flow rate, W_i in g/hr, of an emission for mode i is determined from the following equations:

$$W_i = Q_i \cdot \text{Density} \cdot \left(\frac{C_{Di} - C_{Bi}}{10^6} \cdot \left(1 - \frac{1}{DF_i} \right) \right)$$

Where:

Q_i =Volumetric flow rate standard conditions [m³/hr at STP].

Density=Density of a specific emission (Density_{HC}, Density_{CO}, Density_{CO₂}, Density_{NO_x}) [g/m³].

DF_i =Dilution factor of the dilute exhaust during mode i.

C_{Di} =Concentration of the emission (HC, CO, NO_x) in dilute exhaust extracted from the CVS during mode i [ppm].

C_{Bi} =Concentration of the emission (HC, CO, NO_x) in the background sample during mode i [ppm].

STP=Standard temperature and pressure. All volumetric calculations made for the equations in this section are to be corrected to a standard temperature of 20° C and 101.3 kPa.

(c) Densities for emissions that are to be measured for this test procedure are:

Density_{HC}=576.8 g/m³

Density_{NO_x}=1912 g/m³

Density_{CO}=1164 g/m³

Density_{CO₂}=1829 g/m³

(1) The value of Density_{HC} above is calculated based on the assumption that the fuel used has a carbon to hydrogen ratio of 1:1.85. For other fuels Density_{HC} can be calculated from the following formula:

$$\text{Density}_{HC} = \frac{M_{HC}}{R_{STP}}$$

Where:

M_{HC} =The molecular weight of the hydrocarbon molecule divided by the number of carbon atoms in the molecule [g/mole]

R_{STP} =Ideal gas constant for a gas at STP=0.024065 [m³-mole].

(2) The idealized molecular weight of the exhaust hydrocarbons, i.e., the molecular weight of the hydrocarbon molecule divided by the number of carbon atoms in the molecule, M_{HC} , can be calculated from the following formula:

$$M_{HC} = M_C + \alpha M_H + \beta M_O$$

Where:

M_C =Molecular weight of carbon=12.01 [g/mole]

M_H =Molecular weight of hydrogen=1.008 [g/mole]

M_O =Molecular weight of oxygen=16.00 [g/mole]

α =Hydrogen to carbon ratio of the test fuel